

Rubblizing Heavy Duty Concrete Airfield Pavements



Robert E. Boyer, PhD, PE
Consultant Engineer

Robert E. Boyer, PhD, PE
Consultant engineer

Rubblizing Heavy Duty Concrete Airfield Pavements

FAA Integrated Airport System and U.S. DOD:

- Over 100 million SY of heavy load concrete airfield pavements**
- Greater than 13inches thickness**
- Over 35 years old**
- Needs major rehabilitation < 10 years**

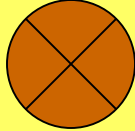
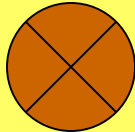
Rubblizing Heavy Duty Concrete Airfield Pavements

Concrete pavement restoration (CPR) procedures:

- Increasingly Costly and Less Effective**
- Resulting Condition: Fair to Good**
- Pavement Ratings Continue to Drop**
- Major Rehabilitation Required/CPR not Effective**

Rubblizing Heavy Duty Concrete Airfield Pavements

In the Past: HMA Overlays Used to Rehabilitate!

- Short Term Relief from Crack Maintenance 
- Thermal Expansion Causes Reflective Cracks
- Reflective Cracks Occur as a Function of:
 - Slab Length
 - Thickness of the HMA Overlay
 - Daily and Seasonal Temperature Differentials
- **Reflective Cracks Always Occur!** 

Rubblizing Heavy Duty Concrete Airfield Pavements

There is a Solution!

RUBBLIZING...

Rubblizing Heavy Duty Concrete Airfield Pavements

Rubblization Process:

- Complete destruction of any slab action**
- De-bonds concrete-to-steel in reinforced concrete**
- Reduces concrete to an in-place crushed base**
- Eliminates inherent distresses**
 - Reflective cracking**
 - D-cracking**
 - Alkali silica reaction, slab rocking, curling, etc. ⁶**

Rubblizing Heavy Duty Concrete Airfield Pavements

State DOT's Adopt Rubblizing AS

Choice Concrete Rehabilitating Technique 1990's

- **From 1994 - 2003, Over 50 million SY Rubblized**
- **Most Between 8-12 Inches Thickness**

HOWEVER

Recent Equipment/Process Developments

- **Demonstrated Success for Heavy Duty Concrete**
- **Up to 26 Inches @ Wright-Patterson AFB, OH**
@ Sefridge ANGB, MI

Rubblizing Heavy Duty Concrete Airfield Pavements

It is Economical...

- None of Existing System is Discarded**
 - Existing Layers Remain to Serve as Structural Layers**
- No Hauling or Disposal Costs**
- Expedites by Minimizing Weather Delays**
 - Subgrade Not Exposed to Elements/Saturated**

Rubblizing Heavy Duty Concrete Airfield Pavements

And Environmentally Friendly

- Saves Natural Resources
 - Reduced Need for New Virgin Aggregates****
- Reduces Air Pollution (truck exhausts & fugitive dust) from Removal**
- Saves Landfill Space**

Rubblizing Heavy Duty Concrete Airfield Pavements

Two Primary Types of Rubblizing Equipment

- Resonant Breaker at WPAFB**
- Multi-Head Breaker at Selfridge ANGB**

Rubblizing Heavy Duty Concrete Airfield Pavements

Wright-Patterson AFB, Ohio

- 40 year old heavy load concrete parking aprons
- The first apron reconstructed in 2000
 - Removal done in a traditional manner
 - massive lifting effort
 - costly and time consuming
 - taking more than three (3) months.
- The second parking ramp was scheduled for reconstruction in the summer of 2002.

Rubblizing Heavy Duty Concrete Airfield Pavements



Resonant Breaker

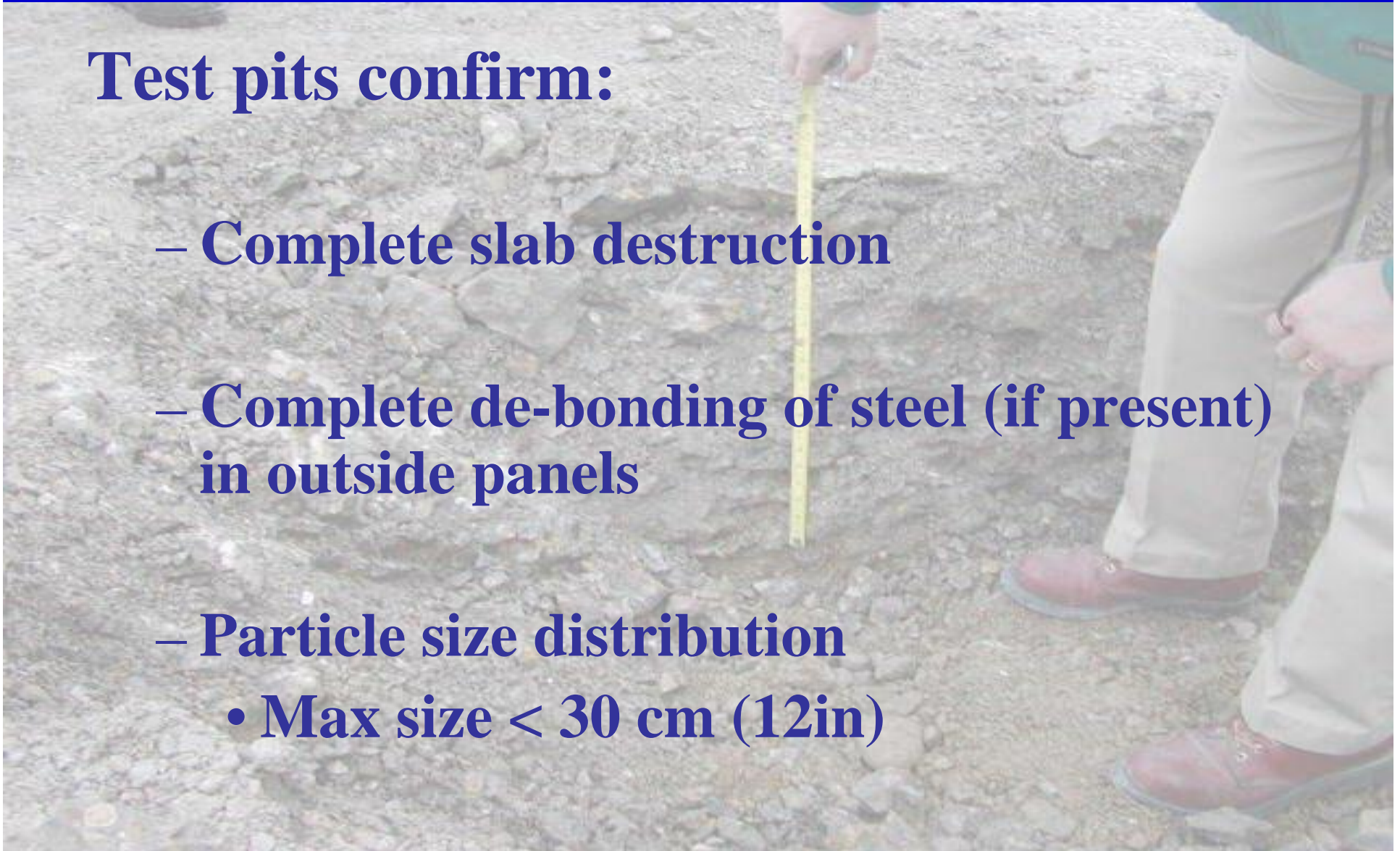
Rubblizing Heavy Duty Concrete Airfield Pavements



Rubblizing Heavy Duty Concrete Airfield Pavements

Test pits confirm:

- Complete slab destruction
- Complete de-bonding of steel (if present)
in outside panels
- Particle size distribution
 - Max size < 30 cm (12in)



Rubblizing Heavy Duty Concrete Airfield Pavements

- **Rubblization at WPAFB:**

- Accomplished in ten days

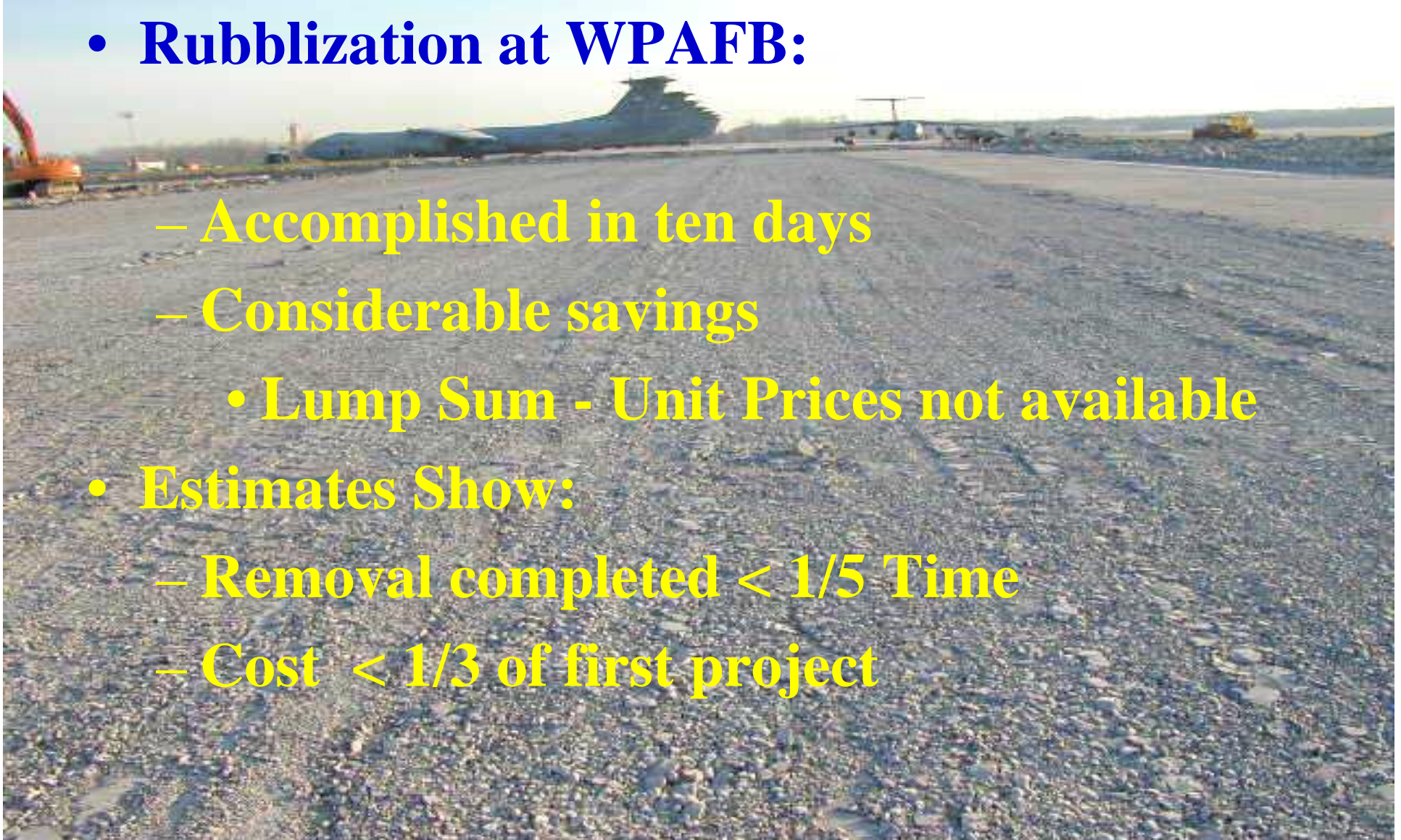
- Considerable savings

- Lump Sum - Unit Prices not available

- **Estimates Show:**

- Removal completed $< 1/5$ Time

- Cost $< 1/3$ of first project



Rubblizing Heavy Duty Concrete Airfield Pavements

Wright-Patterson AFB, Ohio

- 
- Project was designed for removal and replacement
 - Inspection of the rubblized material prior to removal:
 - Rubblized pcc a high quality base material
 - Rolling would prep and ready for an overlay
 - Rubblization provided information on:
 - Benefits for fast, economical removal
 - Proof that process viable on thick concrete

Rubblizing Heavy Duty Concrete Airfield Pavements

Selfridge ANGB, MI



Rubblizing Heavy Duty Concrete Airfield Pavements

Selfridge ANGB, Michigan

- Five military branches of service
- Main heavy load R/W was 9,000-foot with 22 inches of NRCPP
- To minimize disruption to overall base operations:
 - A taxiway used as temporary runway
 - Old pavement was rubblized and left in place as new base
- Runway was turned over to the contractor on April 1st, 2002
 - Back in service on September 15th
 - Faced \$15,000/day liquidated damages

Rubblizing Heavy Duty Concrete Airfield Pavements

Selfridge ANGB, Michigan

- May, 2002, 95,000 SY concrete runway was rubblized in sixteen (16) days.
- The rubblizing specification required that a minimum of 75% of the broken concrete particles not exceed
 - 3 inches at the surface
 - 9 inches in top half of the pavement
 - 15 inches in bottom half of the pavement

Rubblizing Heavy Duty Concrete Airfield Pavements

Multi-Head Breaker



Rubblizing Heavy Duty Concrete Airfield Pavements

Extremely thick PCCP > 50cm (20inches)

- **May have been built in two separate layers or lifts.**
- **Shear plane absorbs some of the breaking force**
- **May need to be pre-broken**

Drop or guillotine style hammer may be used

- **Insure adequate slab destruction through out**
- **Specification compliance**
- **Expedite the rubblization process**

Rubblizing Heavy Duty Concrete Airfield Pavements

Guillotine Breaker



Rubblizing Heavy Duty Concrete Airfield Pavements



Test Pits confirm specification compliance

- **Minimum of 75% of the broken particles**
 - **< 3 inches at the surface**
 - **< 9 inches in the top half**
 - **< 15 inches in the bottom half**

Rubblizing Heavy Duty Concrete Airfield Pavements

After rubblizing with Multiple-Head Breaker

- Prepare surface for HMA overlay
- Roll with two passes of a special “Z” grid roller
 - weighing approximately 23,000 kg (25 tons)
 - to provide a uniform surface
 - to reduce the size of the surface pieces
- Followed by a 22,680kg (25ton) pneumatic-tired roller for final densification and alignment of fractured pieces

Rubblizing Heavy Duty Concrete Airfield Pavements

“Z” Grid Roller



Rubblizing Heavy Duty Concrete Airfield Pavements



22,680kg (25ton) pneumatic-tired roller

- **final densification**
- **alignment of fractured pieces**

Rubblizing Heavy Duty Concrete Airfield Pavements

Procedural steps in the rubblization technique:

- Mill and Remove Any Existing Asphalt
- Install Side and Underdrain Drain System
- Isolate Any Adjacent Sections with Full-Depth Sawcut
- Rubblize the Concrete Pavement
- Cut Off and Remove Any Exposed Steel Reinforcement
- Remove Exposed or Excess Joint Sealing Material
- Roll the Rubblized layer to prepare for the new overlay
- Remove and Patch Any Soft Areas
- Place Asphalt HMA overlay
- Adjust Shoulders grades & Ramps as necessary

Rubblizing Heavy Duty Concrete Airfield Pavements

Rubblization Specifications:

- Performance based specifications
- Acceptable types of breakers
- Types of Rollers
- Particle Size
- Distribution throughout the Pavement
- Should not specify equipment or methods

Rubblizing Heavy Duty Concrete Airfield Pavements

Both Machines are effective but operate in completely different modes

- Resonant breaker: high frequency, low amplitude process
 - Breaking unit produces 3/4 inch amplitude impacts
 - Frequency of 44 per second (hertz)
 - Through a massive steel beam with a foot attached
- Multiple-head breaker: low frequency, high amplitude process
 - Eight pairs of 1200 lbs hammers raised to a height of 0-60 inches
 - Impact the pavement between 30-35 (.5 hertz) times per minute
- Research underway to determine if difference between the two process and their effect on:
 - the underlying subgrade integrity
 - layer permeability
 - effective modulus of the rubblized material

Rubblizing Heavy Duty Concrete Airfield Pavements

Cost Comparisons:

- **Remove/replace verses Rubblize/overlay**
 - **No valid comparisons**
 - **All lump sum contracts – no unit prices**
- **Competitive bids on major highway projects shows rubblization/overlay:**
 - **50% cheaper than remove/replace with HMA**
 - **60% cheaper than remove/replace with PCC**

Rubblizing Heavy Duty Concrete Airfield Pavements

Summary and Conclusions:

- **New Generation of Pavement Breakers and Procedures:**
 - **Rubblization effective for HLAFF pavements up to 26 inches thick**
 - **Adds to the design engineer's arsenal of rehabilitation techniques**
- **Proven to be effective and requires no further reflective crack control**
- **Economical**
- **Environmentally friendly**
- **Eliminates costly and time-consuming total reconstruction**
- **Reduces Pavement Closing Time**
- **Allows Immediate Opening to Traffic**
- **When needed, facilitates removal of PCC**
- **Minimizes overall disruption to Users**

Rubblizing Heavy Duty Concrete Airfield Pavements

Thank You!

Contact Information:

Robert Boyer, PhD, PE

Consultant Engineer

305 Ohio Ave, Suite F

Lynn Haven, Florida 32444

850-265-4751

asphaltnfl@aol.com

Wayne Jones, PE

District Engineer

6113 Bickford Court

Gahanna, Ohio

614-855-1905

wjones@asphaltinstitute.org